sounds uttered by angry birds, but like those that might be made as a feeble protest against some overpowering influence; and the whole behaviour of the birds was utterly unlike that of a crowd deliberately mobbing a bird of prey with angry noises. I have witnessed this on several occasions, but have not seen a similar demonstration against a snake.

"I would ask readers to note, in the professor's second letter, the difference in the behaviour of the birds from that which I have described.

"Mr. Kershaw speaks of 'a great hubbub'; Mr. Hockin of the birds as 'shrieking for all they were worth.' This is surely something of a very different order from the 'faint chirps' of apparently unwilling birds which I heard. Indeed, they at once reminded me of the nightmare in which one attempts to cry out and run away, and can do neither!

"I still believe that it was a case of 'fascination,' although I do not for an instant imply that it was by some mysterious power emanating from the snake.

"May it not be analogous to the strange fascination which the morbid and terrible have for some human beings?

"There are individuals who have a horror of going near to the top of a precipice, for they feel as if they must throw themselves over, yet at the same time they feel constrained to go and look at the chasm which 'fascinates' them. G. H. HALE CARPENTER.

"c/o Medical G.H.Q., Dar es Salaam,
March 12."

SCIENTIFIC TESTS FOR THE SELECTION OF PILOTS FOR THE AIR FORCE.

MODERN aviation by its complex evolutions in a rarefied atmosphere imposes an enormous strain upon the bodily mechanisms. It is important, therefore, that the subjects selected for such work shall be in every way fitted for it, otherwise early breakdown or worse may result to the would-be pilot, in addition to needless expense to the country. The problem of the selection of fit candidates is therefore best approached from the point of view of practical aeronautics.

Considering the effects of a flight in detail, with increasing altitude there is in the first place a deepening of the respiration necessary to secure an adequate oxygen supply. Later, the pulse quickens, and, since a quickened rate of heartbeat entails increased oxygen consumption, there is established a vicious circle—namely, an increased oxygen consumption with a progressively diminishing supply. Therefore, all the bodily devices that render the respiration and the circulation efficient will be called into play—in particular the nervous mechanisms controlling the respiration and circulation. Finally, at great altitudes loss of muscular power and nervous symptoms, subjective and objective, supervene, so that the pilot or observer finds it difficult to perform his work efficiently.

In addition to the effects of altitude, there is, as regards the nervous system, the psychical strain involved during preliminary training, the anxiety of the first solo flights, and, finally, the stress of combatant service. For these reasons it is evident that the candidates for aviation must be of the fittest. As is to be expected, therefore, past experience has shown that candidates with a good physique and previous excellence at sports make the best pilots.

Considering the examination of candidates in more detail, it is important first of all that the candidate shall be able to withstand the effects of work in a rarefied atmosphere. No matter how sound in body and limb, a candidate for the Air Force is useless if he will not wear well under these conditions. From this point of view it is to be borne in mind that previous knowledge of mountain sickness and life at high altitudes is of little service, as there is no evidence of any acclimatisation to altitude in the flying officer.

At the Aviation Candidates' Board particular attention is devoted to the respiratory system, where, in addition to good, healthy lungs and an efficient vital capacity, it is deemed necessary for the candidate to be able to hold the breath for a considerable period of time. In regard to the last test, it has been shown by careful correlation with more complex tests that the power to hold the breath is closely related to the capacity of the candidate to bear the strain of high altitudes.

In addition to an organically sound heart, it is also deemed essential by this Board that the heart shall respond efficiently to work both in respect of increase of pulse-rate and time of return to the normal. This is tested by getting the candidate to step from the ground on to a chair five times in fifteen seconds. The increase in pulse-rate is noted, and the time of return to the rate before the exercise carefully observed. The standards for this test have been set by the examination of a number of successful pilots.

As regards the circulatory standard, it is held that the difference between the pressure in the circulatory system when the heart is beating and the pressure when the heart is resting shall not be great (more than 50 mm. Hg), nor the latter pressure (the diastolic pressure) too low (below 70 mm. Hg).

In regard to the nervous system, besides signs of good nervous stability, it is deemed important that the candidate shall have accurate vision; and examination is particularly directed to rule out cases of concealed hypermetropia, which involves bad landing. A good colour sense is also necessary.

In Allied countries especial attention has been directed to the examination of the labyrinthine mechanism. Although practised, such tests have not so great a vogue in this country. It is to be remarked that, as carried out by means of the revolving chair, the labyrinthine tests yield information in regard to the horizontal canals, whereas in most aerial "stunts" it is the superior canal which is important to the airman. Therefore, if tests for this mechanism be employed in great detail, they should also be directed to the investigation of the superior canal.

A further criticism of these tests is that they are based largely on theoretical considerations, and before standards are adopted in regard to such it is important that a series of healthy and successful pilots should be examined. Since aviators may emerge from a cloud "on their backs" (that is,

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with the machine upside down), it is still a matter of contention as to the absolute degree of efficiency which is required in regard to the labyrinthine mechanism.

On the other hand, in regard to the aural examination, it is beyond doubt that the candidate must have good hearing, if only to detect the noise of defective working of his machine, and also healthy tympanic membranes and uncongested Eustachian tubes, so that he may readily adapt himself to varying changes of pressure.

Good muscular sense is of great importance in a candidate, since there is reason to believe that normally this plays intuitively a considerable part in the accurate balance of a pilot and his machine. Particular attention, therefore, is directed to this point at the British Aviation Candidates' Board.

In regard to reaction times these have been fully investigated by the French authorities, but with the present large demand for candidates for the Air Force it is impossible and unnecessary to carry out such tests in great detail, since during his training this is done to a certain extent by his instructor, and the candidate eventually allotted to the type of machine for which, in this respect, he is found most suitable. This, however, does not mean that such tests should not be applied in special cases.

The flying temperament, it must be confessed, rather baffles assessment, and at the present time it is difficult to eliminate the candidate who may develop an "anxiety neurosis," and therefore later become unsuitable for flying.

Valuable information is obtained from previous medical history, and, to a certain extent, from family history; it is deemed inadvisable, as a general rule, to accept any candidate who has a previous history of serious respiratory trouble or nervous breakdown of any kind. In regard to a history of concussion, however, it has been found that 40 per cent. of successful pilots give a history of concussion of varying duration. Therefore, if at the time of examination there are no signs of nervous instability, it shows that the candidate has a nervous system which can recover well from the effects of concussion. Also the history of the accident leading to such concussion frequently reveals a degree of enthusiastic recklessness characteristic of the "flying" temperament, and for this reason the subject is likely to make a good pilot.

MARTIN FLACK.

THE ZINC ORE RESOURCES OF THE EMPIRE.

THE Mineral Resources Committee of the Imperial Institute has arranged for the publication of a series of monographs on the mineral resources of the Empire, of which the first, dealing with zinc ores, is now issued. Copies of this monograph are obtainable at 2*s*. each, post free, from the Imperial Institute.

Mr. S. J. Johnstone has been chiefly responsible for the work of compilation, and Mr. T. Cook for that of general revision. They have been assisted by Mr. W. S. Robinson, vice-president of the Australian Metal Exchange, and a member of the Imperial Institute Committee for Australia.

In issuing these monographs, the aim of the committee is stated to be not so much to cater for the specialist as to diffuse knowledge of the Empire's mineral resources among those who control and sell them and those who use the products to which they give rise, in the hope that the dissemination of such information will lead to a greater utilisation of these resources within the Empire itself than has been the case in the past.

Although large quantities of zinc ore were mined in the Empire before the war, nearly all the product was exported to and smelted in Germany and Belgium. Thus in 1913, although the Empire produced 20 per cent. of the world's output of zinc ores, its total production of the metal (spelter) was only 6·4 per cent. of the world's output, and not quite half of this was primary or virgin spelter, the remainder being secondary (remelted) metal. Germany and Belgium, on the other hand, produced about 48 per cent. of the world's annual supply of spelter, although they themselves contributed only 23 per cent. of the world's output of zinc ore, the rest of their supplies being obtained from the famous Broken Hill concentrates shipped from Australia.

In the last pre-war year Germany led the way in ore-production, followed by New South Wales, the United States of America, Spain, and Italy, in order of magnitude. These are the principal ore-producing countries.

The most important ore-minerals of zinc are the sulphide, ZnS, known as zincblende and also as sphalerite, and the carbonate, $ZnCO_3$, known as calamine and sometimes also as Smithsonite; the former is by far the more important source of the metal. Special mention should also be made of Franklinite, a mangano-ferrate of iron, manganese, and zinc, found in large quantities in New Jersey, U.S.A., which is a source not only of zinc, but also of ferromanganese. The silicate ore, hemimorphite, $3ZnOSiO_2 + H_2O$, also serves as one of the minor sources of the metal.

Zinc ores occur, and have been mined for some time, in many parts of the United Kingdom; of these a considerable proportion were *exported* before the war to the Continent for smelting. On the other hand, ores from foreign countries have, at the same time, been *imported* and smelted here, a condition of things which would be incredible if it were not true.

The most considerable source of zinc ore in the Empire is the deposit in the Broken Hill district, New South Wales, which is situated at the southern extremity of the Barrier range. The extreme length of the ore-bearing ridge is about two miles, and the report gives information as to how the ore changes in passing from the oxidised outcrop to the unaltered sulphide minerals below.

Stated very briefly, this monograph gives, in the first place, a short statistical account of the world's production of zinc ores and zinc, and describes the ore-minerals; then follows a section devoted to the principal ore-deposits of the Em-

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